Technical Excellence

DAU Hot Topics Forum
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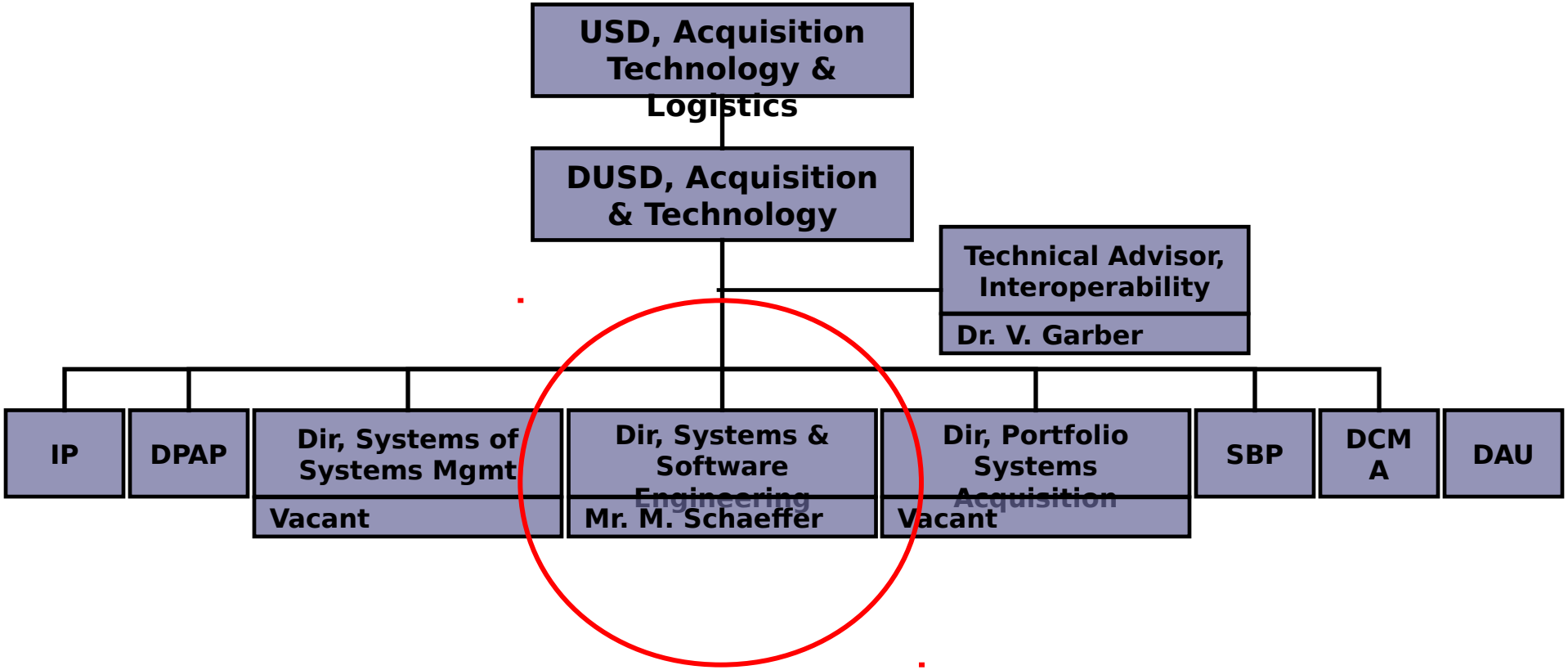
Systems and Software Engineering, Enterprise Development

Office of the Under Secretary of Defense (AT&L)

DUSD, Acquisition & Technology

as of June 1, 2006



Systems and Software Engineering Organizational Profile

Director, Systems & Software Engineering

Mark Schaeffer SES

Deputy Director Enterprise Development	Deputy Director Developmental Test & Evaluation	Deputy Director Software & System Assurance	Deputy Director Assessments & Support
Bob Skalamera SES	Chris DiPetto SES	VACANT SES	Dave Castellano SES
CORE COMPETENCIES	**CORE COMPETENCIES**	**CORE COMPETENCIES**	**CORE COMPETENCIES**

• SE Policy
• SE Guidance
  • SE in *Defense Acquisition Guidebook*
  • Technical Planning
  • Risk Management
  • Reliability & Maintainability
  • Contracting for SE
  • SoS SE Guide
• SE Education and Training
  • DAU SE Curriculum
  • SPRDE Certification Reqt
• Special Initiatives
  • Corrosion
  • RTOC
  • VE
	• DT&E Policy
	• DT&E Guidance
	  • T&E in *Defense Acquisition Guidebook*
	  • TEMP Development Process
	• DT&E Education and Training
	  • DAU DT&E Curriculum
	  • DT&E Certification Reqt
	• Joint Testing, Capabilities & Infrastructure
	• Targets Oversight
	• Modeling & Simulation
	• Acquisition System Safety
		• TBD	• Support of ACAT I and other special interest programs (MDAP, MAIS)
			• Assessment Methodology (Defense Acquisition Program Support – DAPS)
			• T&E Oversight and Assessment of Operational Test Readiness (AOTR)
			• SE/T&E Review of Defense Acquisition Executive Summary Assessments (DAES)
			• Lean/6-Sigma Training/Cert

Acquisition program excellence through sound systems and software

Some Definitions of Systems Engineering

Mil-Std 499A [1974]: The application of scientific and engineering efforts to:

(1)transform an operational need into a description of system performance parameters and a system configuration through the use of an iterative process of definition, synthesis, analysis, design, test, and evaluation;

(2)integrate related technical parameters and ensure compatibility of all related, functional, and program interfaces in a manner that optimizes the total system definition and design;

(3)integrate reliability, maintainability, safety, survivability, human, and other such factors into the total technical engineering effort to meet cost, schedule, and technical performance objectives.

INCOSE: SE is an interdisciplinary approach and means to enable the realization of successful systems.

NASA: SE is a robust approach to the design, creation, and operation of systems.

Sage: The design, production, and maintenance of trustworthy systems within cost and time constraints.

Forsberg & Mooz: The application of the *system analysis and design process* and the *integration and verification process* to the logical sequence of the *technical aspect of the project life cycle*.

DoD has adopted….

Systems engineering is an ***interdisciplinary approach encompassing the entire technical effort to evolve and verify an integrated and total life-cycle balanced set of system, people, and process solutions that satisfy customer needs.*** *Systems engineering is the* ***integrating mechanism*** *across the technical efforts related to the development, manufacturing, verification, deployment, operations, support, disposal of, and user training for systems and their life cycle processes. System engineering* ***develops technical information to support the program management decision-making process****. For example, systems engineers manage and control the definition and management of the system configuration and the translation of the system definition into work breakdown structures.*

Adopted from ANSI/EIA-632, "Processes for Engineering a System"

Top Five Systems Engineering Issues

- Lack of awareness of the importance, value, timing, accountability, and organizational structure of SE on programs
- Adequate, qualified resources are generally not available within government and industry for allocation on major programs
- Insufficient SE tools and environments to effectively execute SE on programs
- Poor initial program formulation
- Requirements definition, development, and management is not applied consistently and effectively

NDIA Study in January 2003

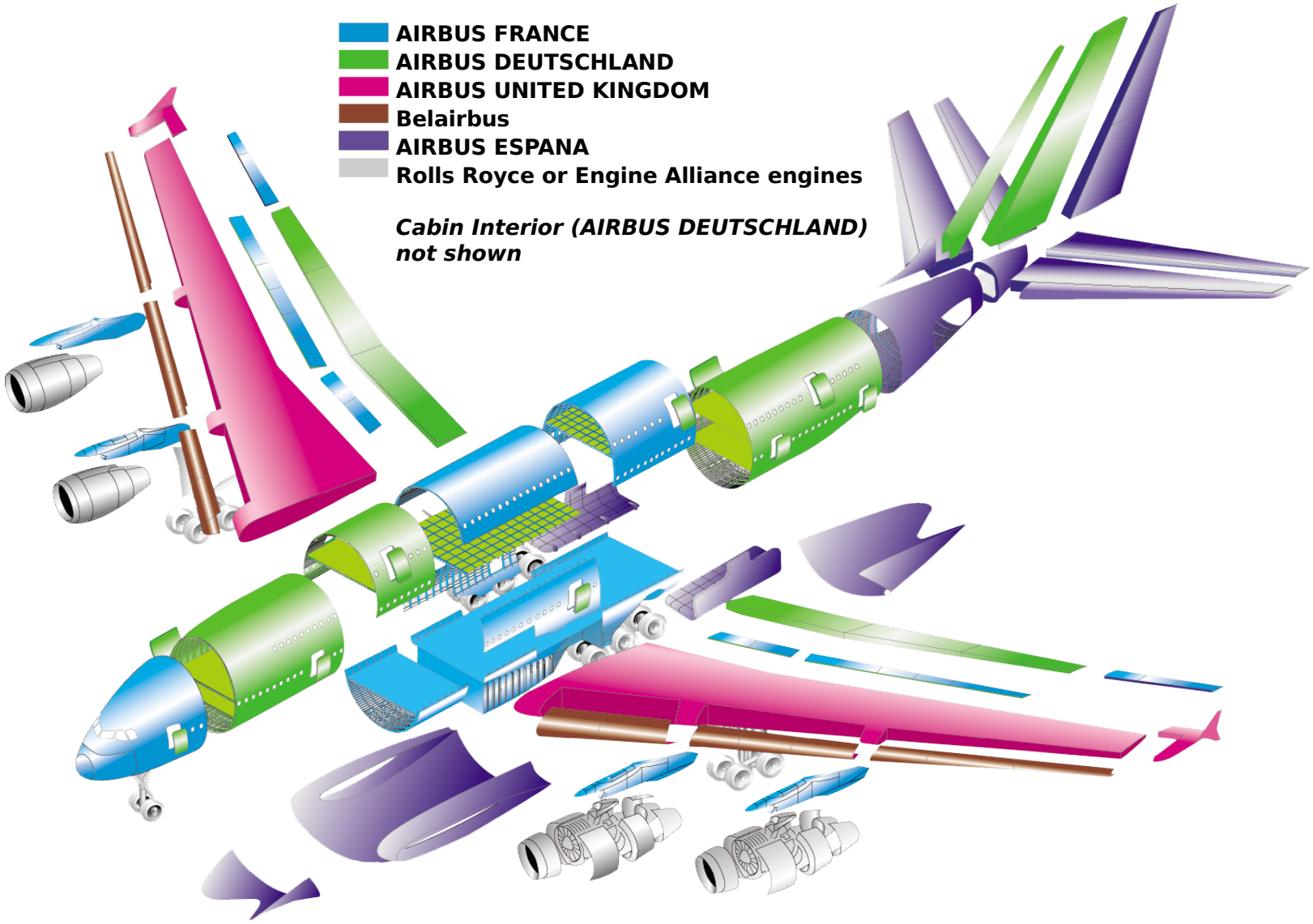
DoD Systems Engineering Shortfalls*

- Root cause of failures on programs include:
  - Inadequate understanding of requirements
  - Lack of systems engineering discipline, authority, and resources
  - Lack of technical planning and oversight
  - Stovepipe developments with late integration
  - Lack of subject matter expertise
  - Availability of systems integration facilities
  - Low visibility of software risk
  - Technology maturity overestimated

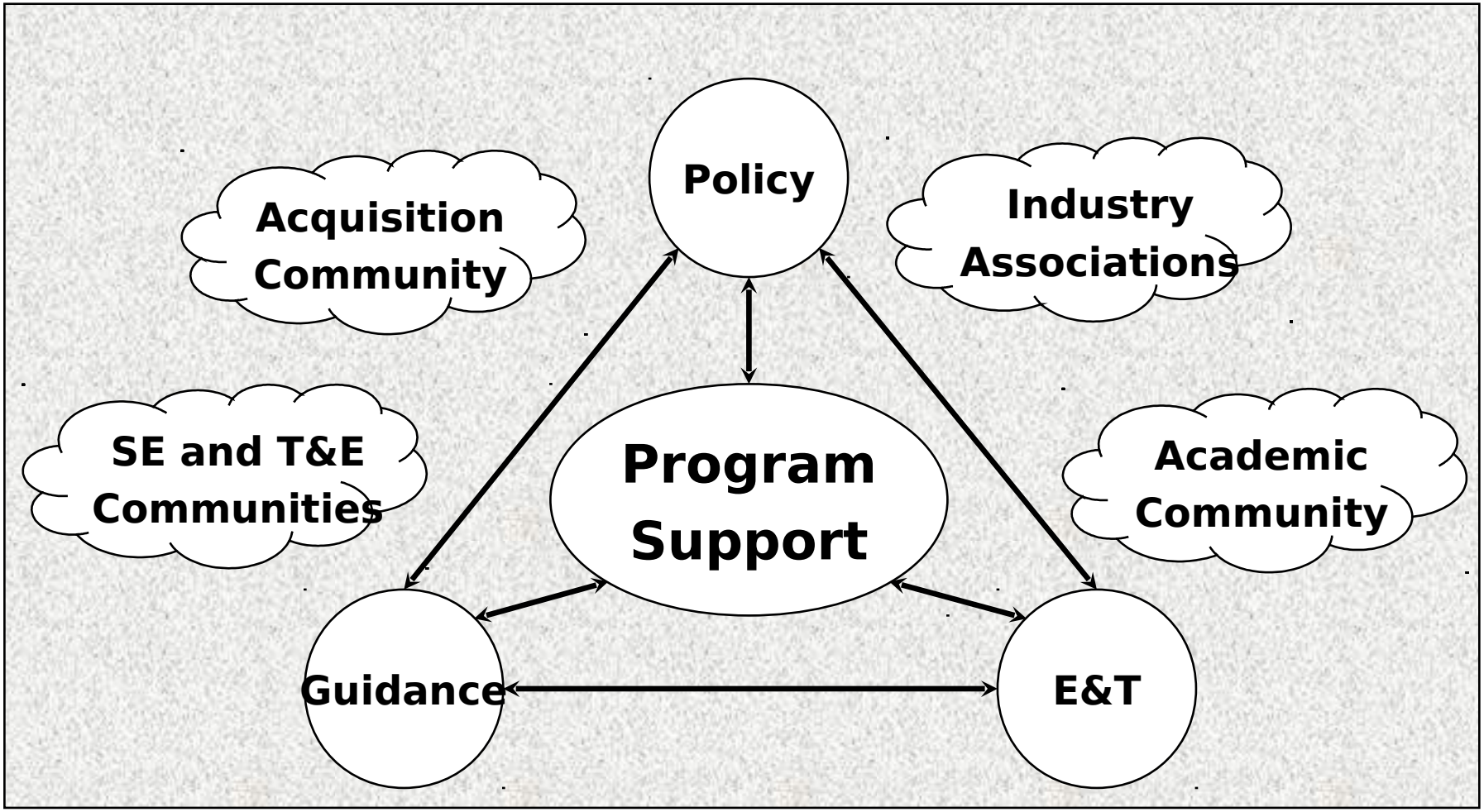
Major contributors to poor program performance

Current Trends in System Development:

Airbus A380 industrial work share



Systems Engineering Revitalization Framework



Driving Technical Excellence into Programs!

What We Have Done To Revitalize Systems Engineering

- Established SE Forum—senior-level focus within DoD
- Issued Department-wide systems engineering (SE) policy
- Issued guidance on SE and test and evaluation (T&E)
- Instituted system-level assessments in support of OSD major acquisition program oversight role
- Working with Defense Acquisition University to revise SE, T&E, and enabling career fields curricula (Acq, PM, CM, FM)
- Integrating Developmental T&E with SE policy and assessment functions—focused on effective, early engagement of both
- Instituting a renewed emphasis on modeling and simulation
- Leveraging close working relationships with industry and academia

DoD Response Policy

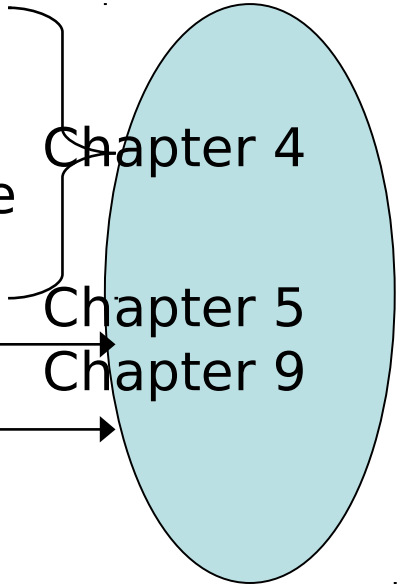
- All programs shall develop a SE Plan (SEP)
- Each PEO shall have a lead or chief systems engineer who monitors SE implementation within program portfolio
- Event-driven technical reviews with entry criteria and independent subject matter expert participation
- OSD shall review program's SEP for major acquisition programs (ACAT ID and IAM)

Technical Reviews Recommended Practices

- Event based with objective entry criteria defined upfront
- Only as good as who conducts them
  - Engagement of Technical Authority
  - Chair independent of program team
  - Independent subject matter experts, determined by Chair
  - Involve all stakeholders
- Review entire program from technical perspective
  - Cost, schedule, and performance
  - All technical products (specifications, baselines, risks, cost estimates)
  - By all stakeholders
- Result in program decisions and changes—vice “check in the box”
  - Serve as technical assessment product for program managers
- Taken as a whole series, form a major part (backbone) of technical planning as documented in the SEP

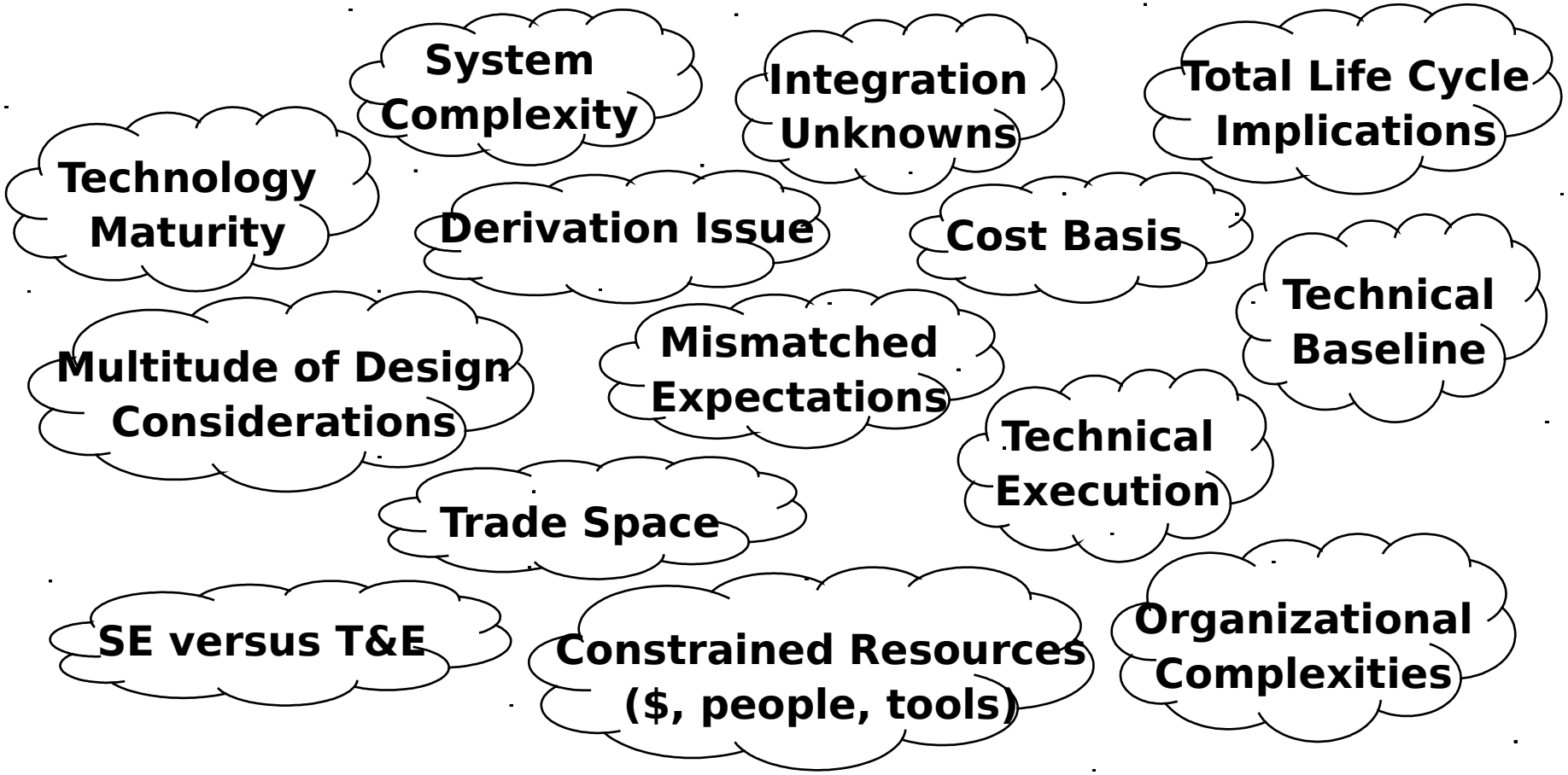
DoD Response Guidance and Tools

- *Defense Acquisition Guidebook*:
  - SE in DoD Acquisition
  - SE Processes
  - SE Implementation in the System Life Cycle
  - SE Tools and Techniques, and SE Resources
  - Life Cycle Logistics in SE
  - Test & Evaluation



- SEP:
  - Interim guidance
  - Preparation Guide
  - Twenty-five focus areas to address in technical planning
    - One each, tailored for Milestones A, B, and C

Technical Planning Drivers



What does "SE" mean on your program?

SEP Stakeholders

Program Manager

PEO

Other Programs

Statutory and Regulatory Bodies

Certifiers

Users

Cost Estimators

New Program Personnel

Lead Systems Engineer

Prime Contractor

Subcontractors

Lower-tier Suppliers

Functional Leadership

IPTs

Testers

Logisticians

Milestone Decision Authority

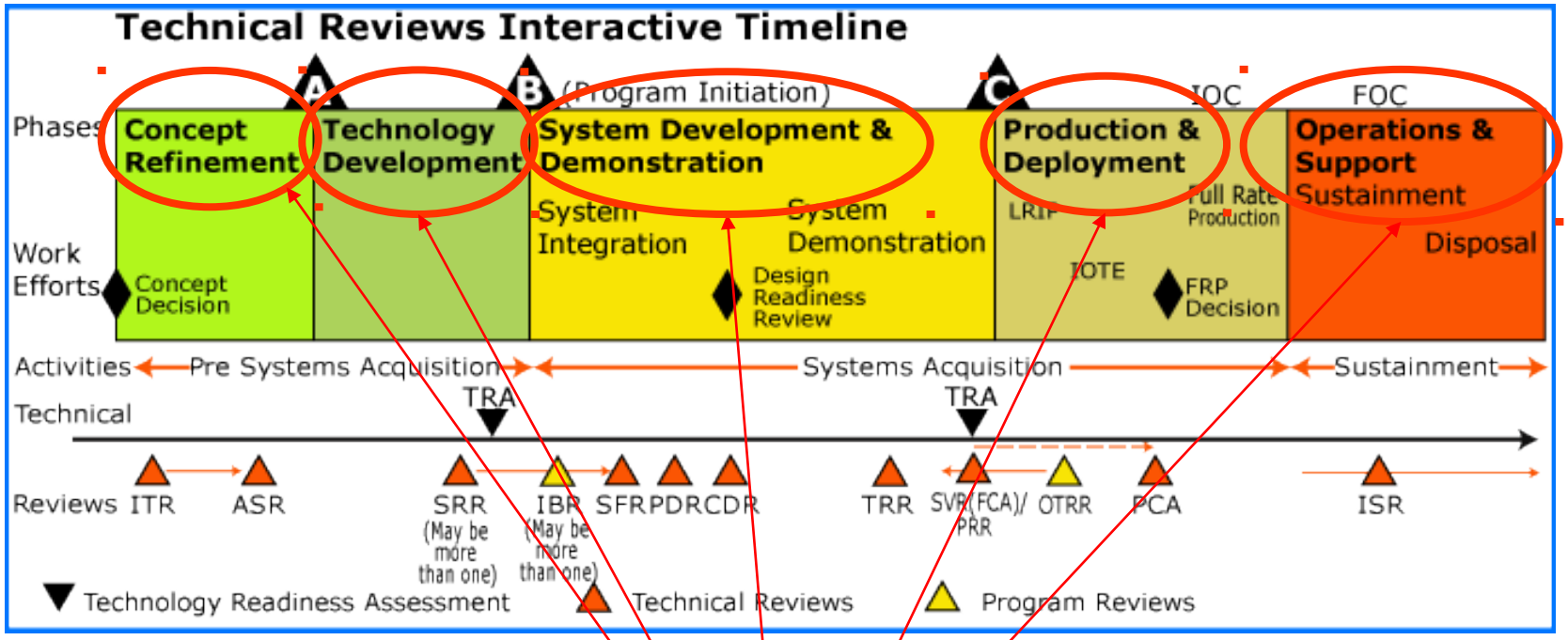
A SEP Provides a Means for Collective Understanding Among All Stakeholders as to Program's Technical Approach

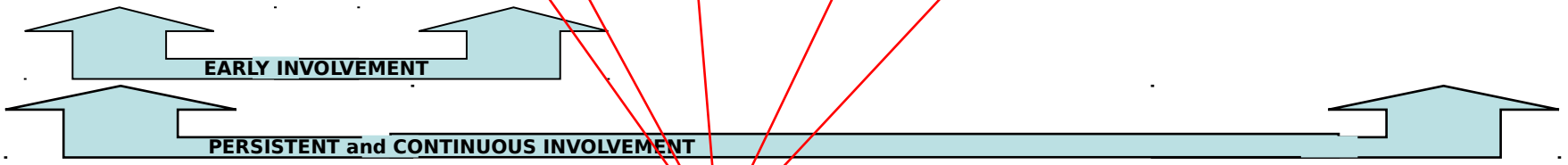
Driving Technical Rigor Back into Programs
"Importance and Criticality of the SEP"

- Program's SEP provides insight into every aspect of a program's technical plan, focusing on:
  - What are the program requirements?
  - Who has responsibility and authority for managing technical issues—what is the technical staffing and organization?
  - How will the technical baseline be managed and controlled?
  - What is the technical review process?
  - How is the technical effort linked to overall management of the program?
- Living document with use, application, and updates clearly evident

The SEP is fundamental to technical and programmatic execution on a program

Scope of Technical Planning



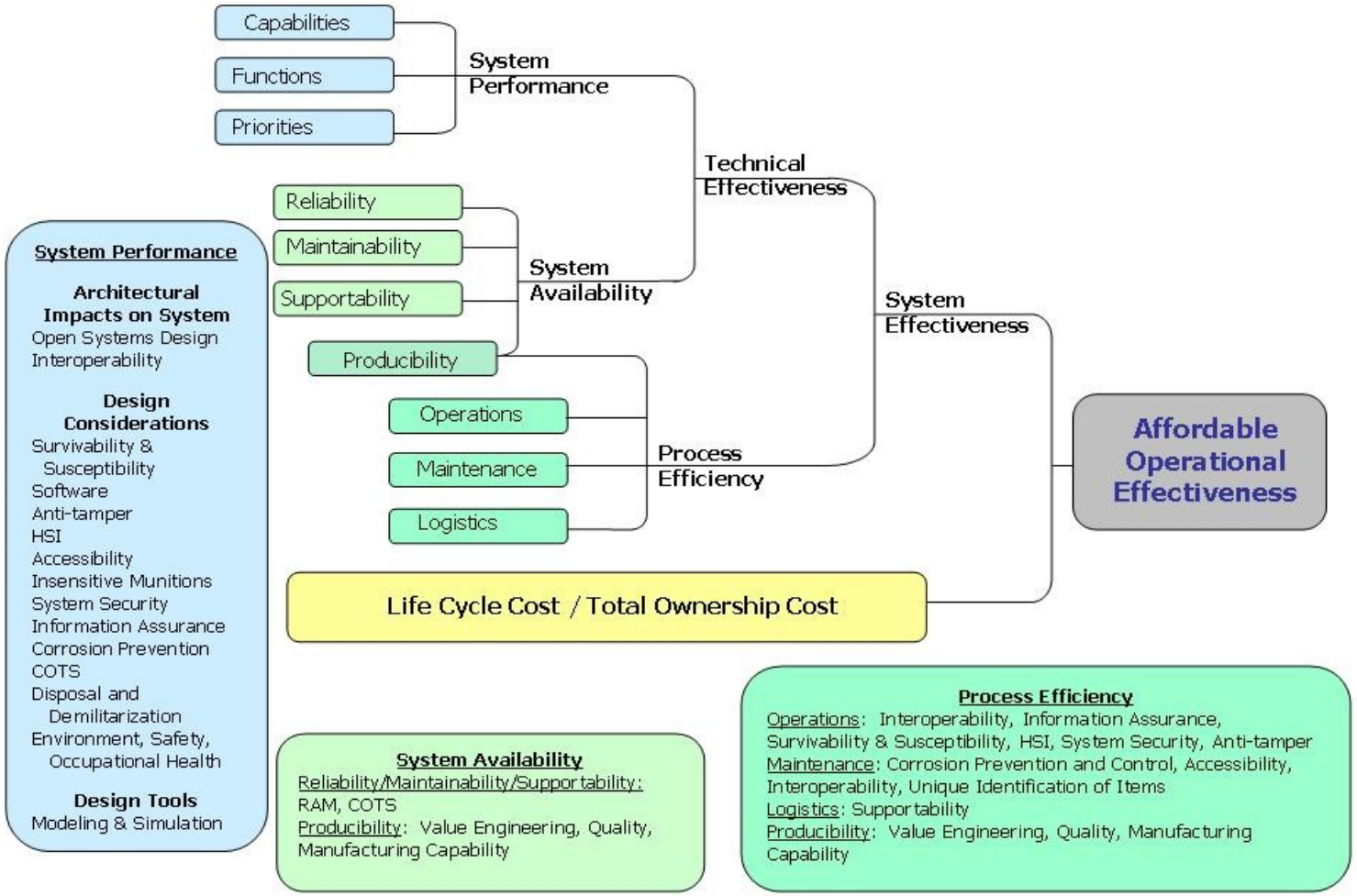


Sound technical planning is needed in EVERY acquisition phase

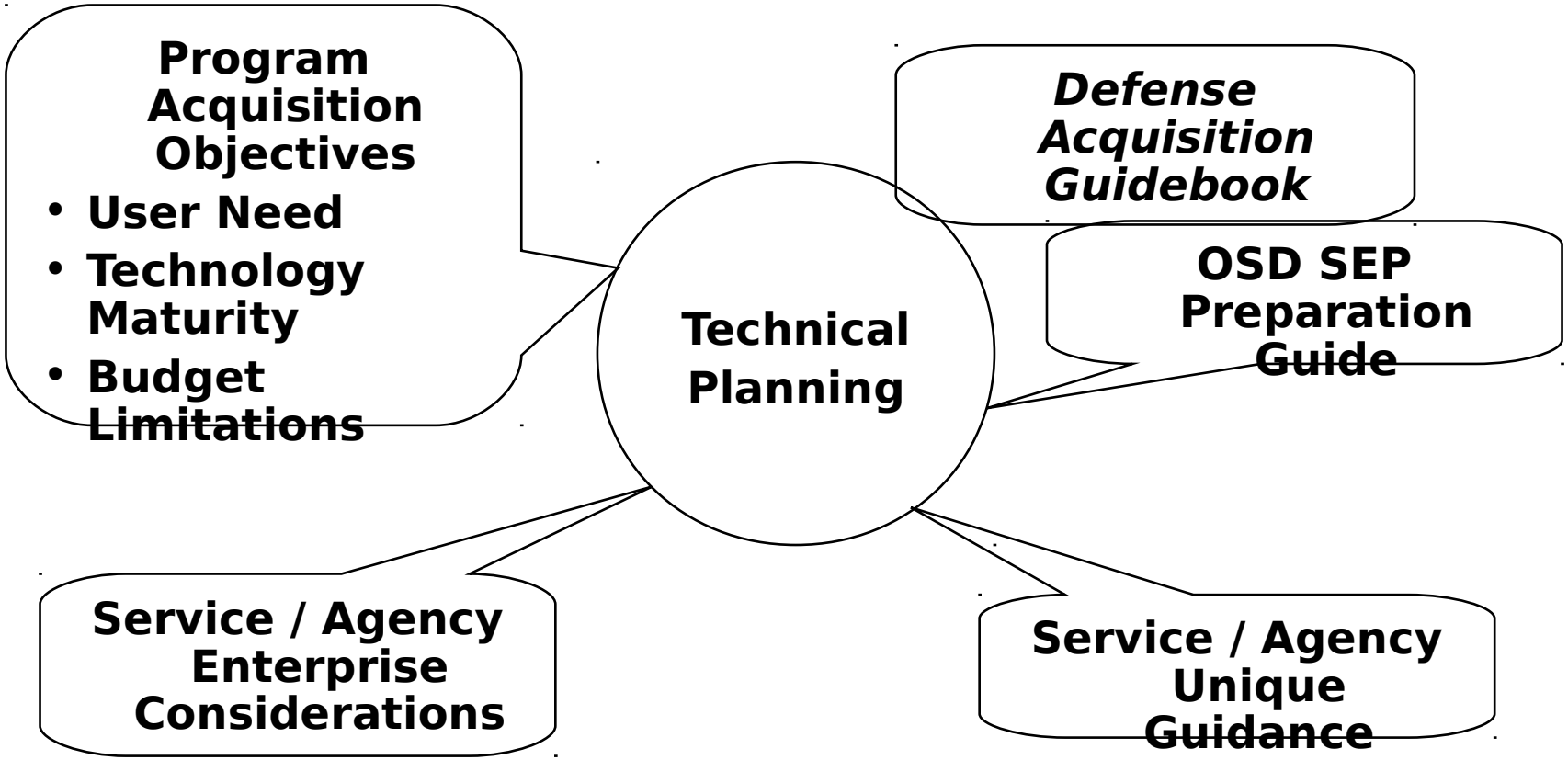
SEP Focus Areas for Technical Planning in Concept Refinement / Technology Development

- Program Requirements
  - **Desired capabilities; required attributes**
  - **Potential statutory/regulatory, specified/derived performance, certifications, design considerations**
  - **Enabling technologies**
  - **Cost/schedule constraints**
  - **Future planning**
- Technical Staffing/Organization
  - Technical authority
  - Lead Systems Engineer
  - **SE role in TD IPT**
  - IPT organization and coordination
  - Organizational depth
- Technical Baseline Management
  - Who is responsible
  - Definition of baselines
  - **ICD/CDD traceability**
  - Technical maturity and risk
- Technical Review Planning
  - Event-driven reviews
  - Management of reviews
  - Technical authority chair
  - Key stakeholder participation
  - Peer participation
- Integration with Overall Management of the Program
  - Linkage with other program plans
  - Program manager’s role in technical reviews
  - Risk management integration
  - Test and support strategy
  - Contracting considerations

Important Design Considerations
"The Fishbone"



Technical Planning Considerations



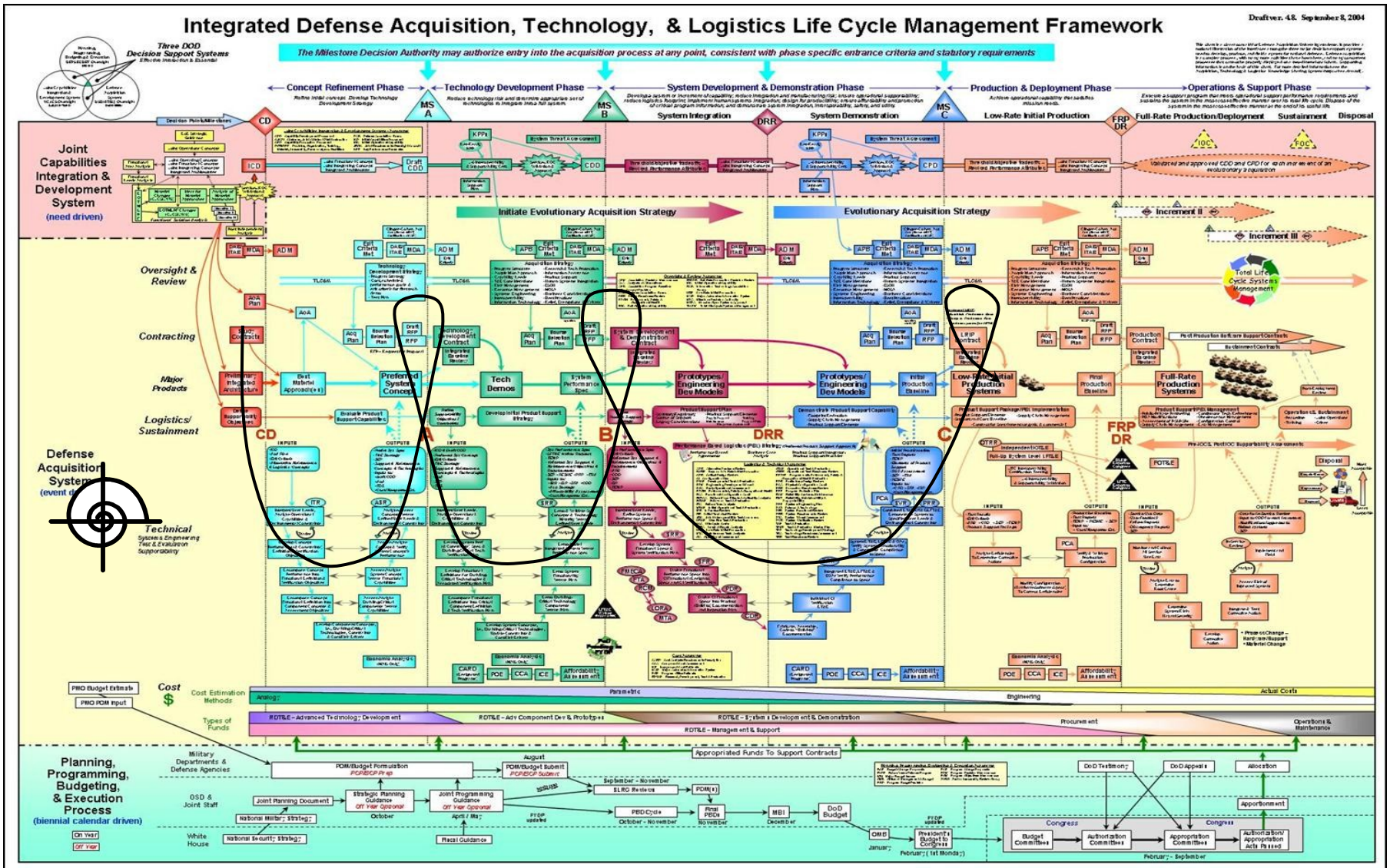
This is the Program Manager's Planning!

DoD Response Guidance and Tools (con't)

- SE in the Integrated Defense AT&L Life Cycle Management Framework Chart (v5.2)
- Guides:
  - Reliability, Availability, and Maintainability → Published!
  - Integrated Master Plan/Integrated Master Schedule → Published!
  - Risk Management → In Coordination
  - Contracting for SE → In Final Drafting
- Tools:
  - Defense Acquisition Program Support
  - Initial Operational T&E (IOT&E) Readiness
  - Capability Maturity Model Integrated Acquisition Module (CMMI-AM)

http://www.acq.osd.mil/ds/se

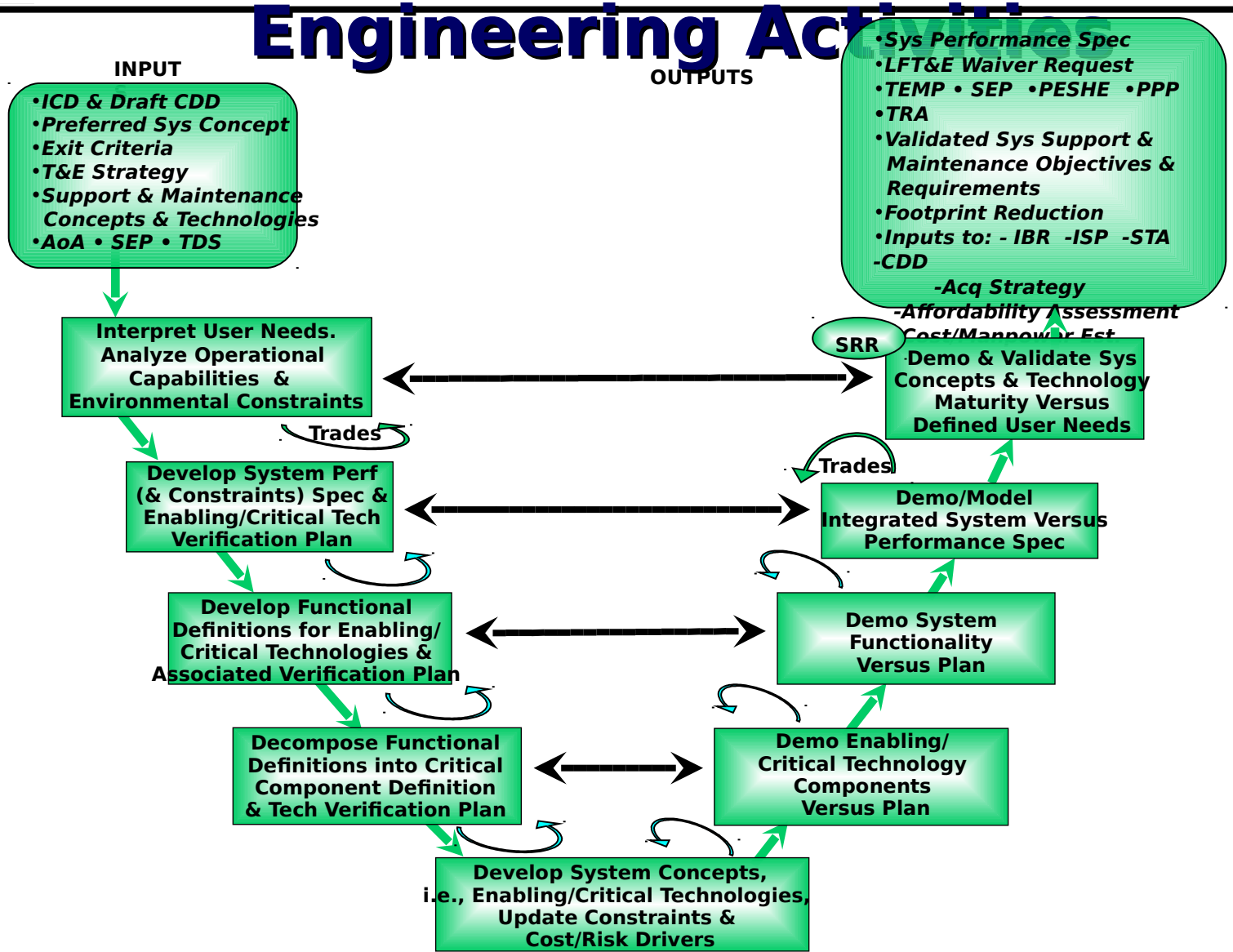
SE in the System Life Cycle
"The Wall Chart"



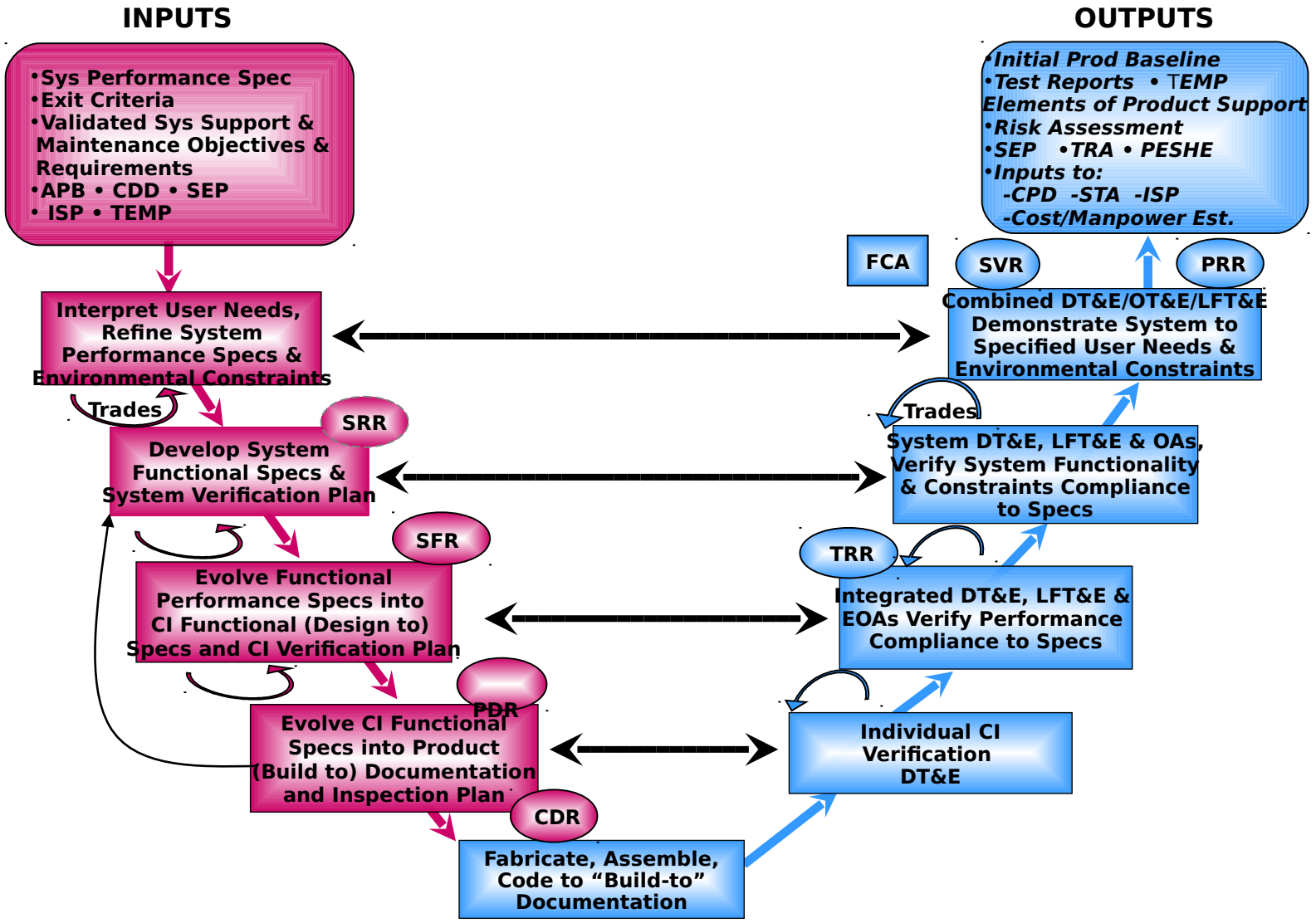
Concept Refinement Phase: Key Systems Engineering Activities

INPUTS
•ICD
•AoA Plan
•Exit Criteria
•Alternative Maintenance & Logistics Concepts
OUTPUTS
•Prelim Sys Spec
•T&E Strategy
•SEP
•Support & Maintenance Concepts & Technologies
•Inputs to:
-draft CDD - TDS
-AoA
-Cost/Manpower Est.
ITR
ASR
Interpret User Needs, Analyze Operational Capabilities & Environmental Constraints
Analyze/Assess Concepts Versus Defined User Needs & Environmental Constraints
Trade
Trades
Develop Concept Performance (& Constraints) Definition & Verification Objectives
Assess/Analyze Concept & Verify System Concept's Performance
Decompose Concept Performance into Functional Definition & Verification Objectives
Analyze/Assess System Concept Versus Functional Capabilities
Decompose Concept Functional Definition into Concept Components & Assessment Objectives
Analyze/Assess Enabling/Critical Components Versus Capabilities
Develop Component Concepts, i.e., Enabling/Critical Technologies, Constraints & Cost/Risk Drivers

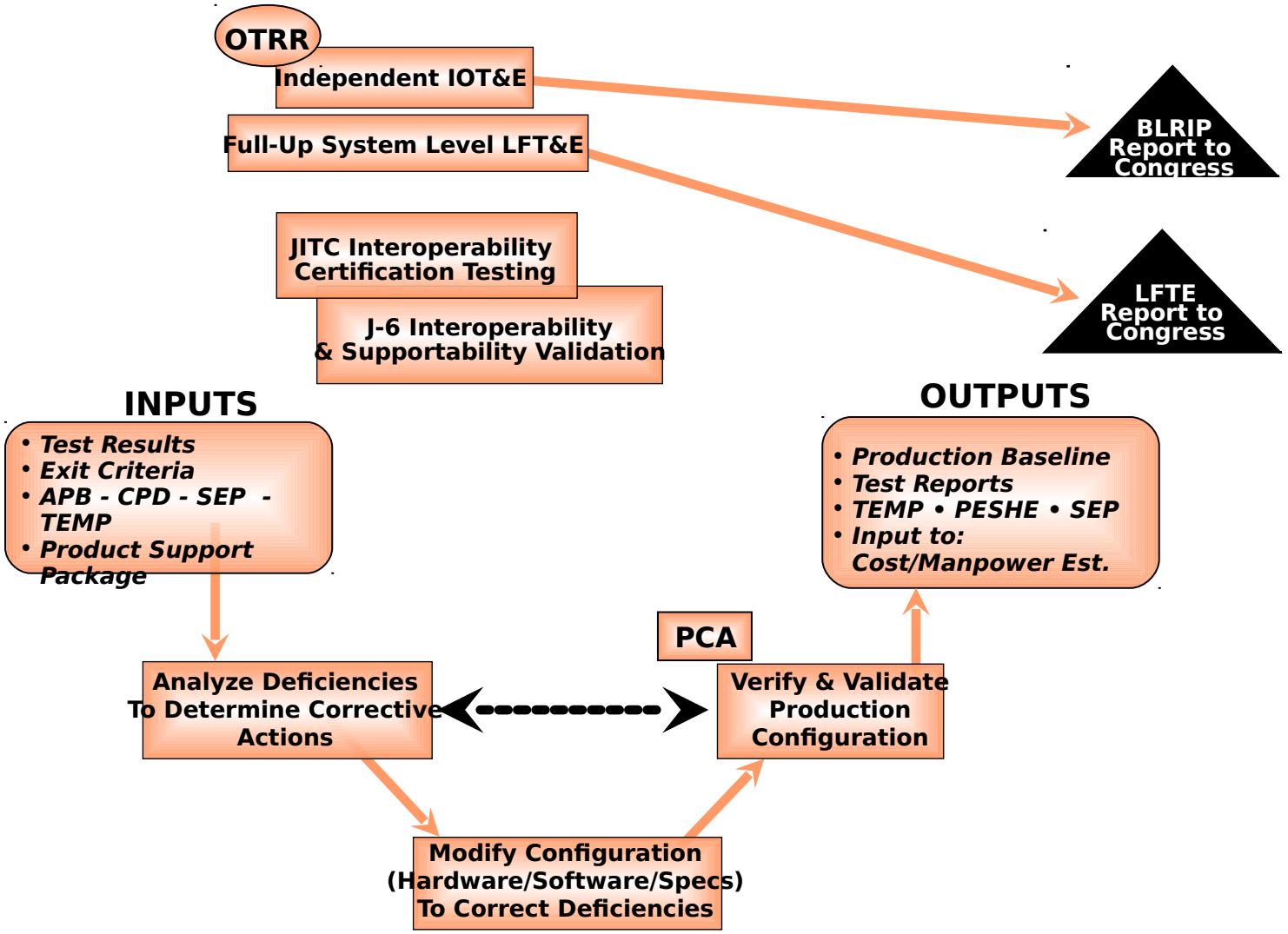
Technology Development Phase: Key Systems Engineering Activities


INPUT
•ICD & Draft CDD
•Preferred Sys Concept
•Exit Criteria
•T&E Strategy
•Support & Maintenance Concepts & Technologies
•AoA • SEP • TDS
OUTPUTS
•Sys Performance Spec
•LFT&E Waiver Request
•TEMP • SEP •PESHE •PPP
•TRA
•Validated Sys Support & Maintenance Objectives & Requirements
•Footprint Reduction
•Inputs to: - IBR -ISP -STA -CDD
-Acq Strategy
-Affordability Assessment
Interpret User Needs. Analyze Operational Capabilities & Environmental Constraints
Trades
Develop System Perf (& Constraints) Spec & Enabling/Critical Tech Verification Plan
Develop Functional Definitions for Enabling/ Critical Technologies & Associated Verification Plan
Decompose Functional Definitions into Critical Component Definition & Tech Verification Plan
Develop System Concepts, i.e., Enabling/Critical Technologies, Update Constraints & Cost/Risk Drivers
SRR
Demo & Validate Sys Concepts & Technology Maturity Versus Defined User Needs
Trades
Demo/Model Integrated System Versus Performance Spec
Demo System Functionality Versus Plan
Demo Enabling/ Critical Technology Components Versus Plan

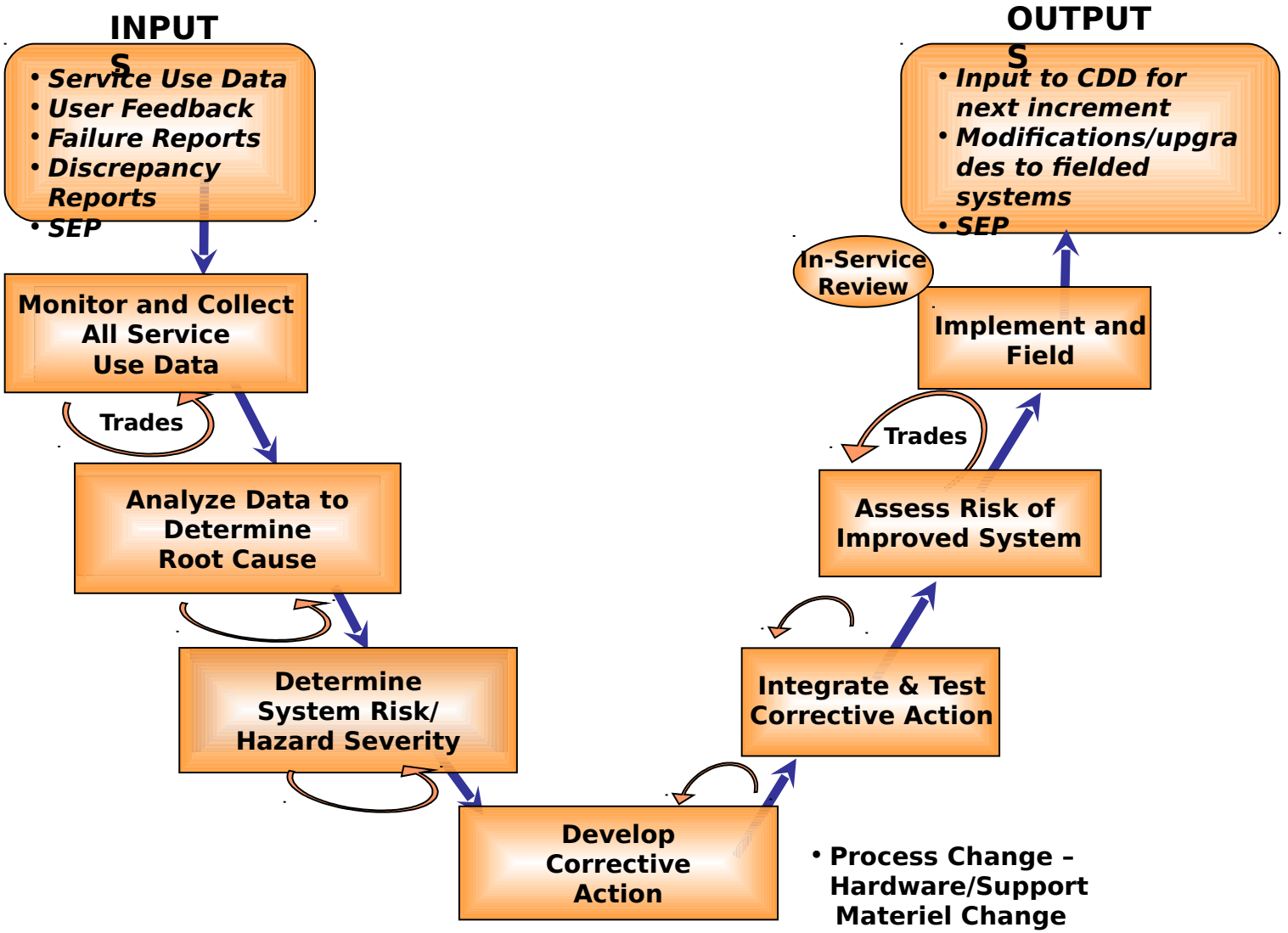
System Development and Demonstration Phase


INPUTS
•Sys Performance Spec
•Exit Criteria
•Validated Sys Support & Maintenance Objectives & Requirements
•APB • CDD • SEP
• ISP • TEMP
OUTPUTS
•Initial Prod Baseline
•Test Reports • TEMP
Elements of Product Support
•Risk Assessment
•SEP •TRA • PESHE
•Inputs to:
-CPD -STA -ISP
-Cost/Manpower Est.
FCA
SVR
PRR
Interpret User Needs, Refine System Performance Specs & Environmental Constraints
Combined DT&E/OT&E/LFT&E Demonstrate System to Specified User Needs & Environmental Constraints
Trades
SRR
Develop System Functional Specs & System Verification Plan
Trades
System DT&E, LFT&E & OAs, Verify System Functionality & Constraints Compliance to Specs
SFR
Evolve Functional Performance Specs into CI Functional (Design to) Specs and CI Verification Plan
TRR
Integrated DT&E, LFT&E & EOAs Verify Performance Compliance to Specs
PDR
Evolve CI Functional Specs into Product (Build to) Documentation and Inspection Plan
Individual CI Verification DT&E
CDR
Fabricate, Assemble, Code to "Build-to" Documentation

Systems Engineering: Production & Deployment Phase



Systems Engineering: Operations and Support Phase



DoD Response Education, Training, and Outreach

- Formal training updates across key career fields: SE, T&E, Acquisition, Program Management, Contract Management, Finance Management
- Continuous learning, on-line courses
  - Reliability and Maintainability, Technical Reviews, and System Safety already available
  - Technical Planning, Modeling and Simulation, and Contracting for SE in development
- University engagement
- Director-level outreach to industry
  - Hosting of and speaking at conferences and symposia
  - Speaking to industry at senior leadership levels

ttp://www.dau.mil/basedocs/continuouslearning.asp

Driving Technical Rigor into Programs

Topic	Systems Engineering	Test & Evaluation	Risk Management	Exit Criteria	Acquisition Strategy
Focus Areas	Requirements	V&V Traceability	Risk ID	Mission Systems	
	Organization & Staffing	Test Resources	Risk Analysis	Support	
	Technical Reviews	Test Articles	Risk Mitigation Planning	Manufacturing	
	Technical Baseline	Evaluation	Risk Tracking	R & M	
	Linkage w/ Other Program Mgmt & Controls	Linkage w/ Other Program Mgmt & Controls	Evidence of Effectiveness	Net Centric	Contractual Approach
Product	SEP	TEMP	RM Plan	Phase Exit Criteria	ASR

Examples

SEP Observations

- Descriptions vice plans
  - Regurgitated theory
  - Generic text, applicable to _____
  - Disconnected discussion
  - No numbers or specifics
  - No names
  - No timeframes or ordered relationships
    - What
    - How
    - Why
    - Where
    - Who
    - When
- Not reflective of known industry best practice
  - Technical baselines
  - Technical reviews
    - Entry criteria for technical reviews
    - Peer participation

Driving Technical Rigor Back into Programs
"Emerging SEP Comments (First Drafts)"

(not systemic across all programs)

- Incomplete discussion of program requirements
  - Missing categories such as statutory, regulatory, or certifications
- Minimal discussion of program IPTs
  - Need to identify technical authority, lead systems engineer, and key stakeholders
  - Addresses part of SE organization, such as prime; no mention of government, subcontractors, or suppliers
- Incomplete technical baseline
  - How does the program go from CDD to product—traceability?
  - Linkage to EVM—not able to measure technical maturity via baselines
- Incomplete discussion of technical reviews
  - How many, for what (should tie to baselines and systems/subsystems/configuration items), and by whom (should tie to staffing)?
  - Lacking specific entry criteria
  - Peer reviews
- Integration with other management planning
  - Linkage with acquisition strategy, IMP, IMS, logistics, testing, and risk management
  - Schedule adequacy—success-oriented vice event-driven; schedule realism
  - Contracting for SE

75 SEPs reviewed from 46 programs

Compelling Need to Engage with Programs Early in Process

Driving Technical Rigor Back Into Programs "Program Support Reviews"

- Program Support Reviews provide insight into a program's technical execution focusing on:
  - SE as envisioned in program's technical planning
  - T&E as captured in verification and validation strategy
  - Risk management—integrated, effective and resourced
  - Milestone exit criteria as captured in Acquisition Decision Memo
  - Acquisition strategy as captured in Acquisition Strategy Report
- Independent, cross-functional view aimed at

The Program Support Review reduces risk in the technical and programmatic execution on a program

Samples of Program Support Review "Strengths"

- Experienced and dedicated program office teams
- Strong teaming between prime contractors, sub-contractors, program offices and engineering support
- Use of well defined and disciplined SE processes
- Proactive use of independent review teams
- Successful management of external interfaces
- Corporate commitment to process improvement
- Appropriate focus on performance-based logistics
- Notable manufacturing processes
- Focus on DoD initiatives
- Excellent risk management practices

But not on all Programs…

Are We on the Right Track?

- Study Findings
  - Inadequate understanding of requirements
  - Lack of SE discipline, authority, and resources
  - Lack of technical planning and oversight
  - Stovepipe developments with late integration
  - Lack of subject matter expertise at integration level
- Programs/SEPs
  - Incomplete discussion of program requirements
  - Minimal discussion of technical authority and IPTs
  - Incomplete technical baseline approach
  - Incomplete discussion of technical reviews
  - Integration of SEP sections

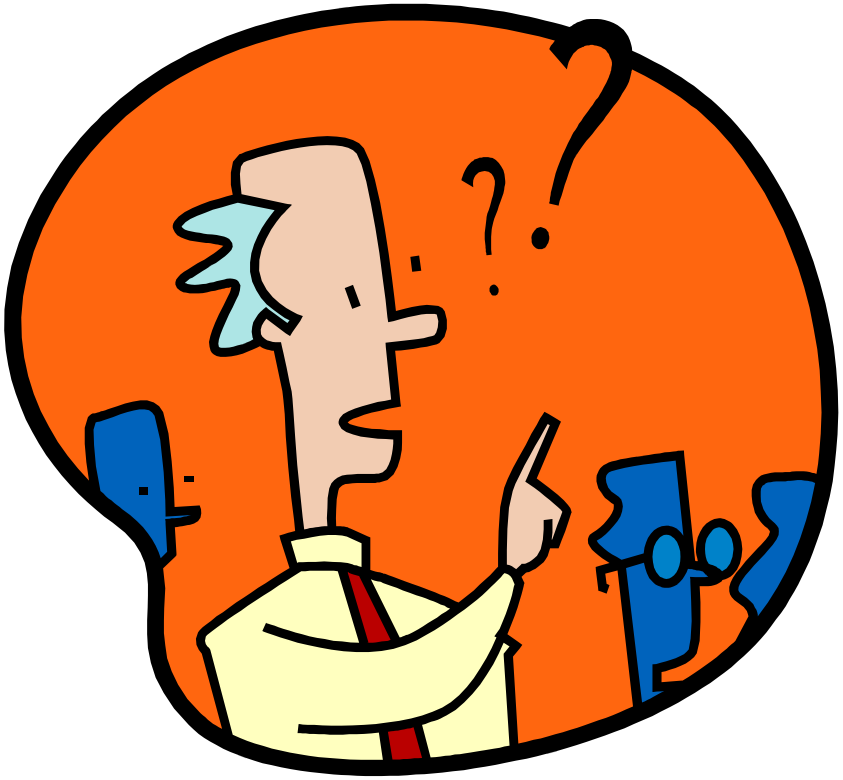
Strong correlation between initial findings and SEP and Program Support findings

Summary

- OSD's fundamental role is to set policy, provide relevant and effective education and training, and foster communication throughout the community—much has been accomplished
- OSD cannot do everything…nor should we
- Challenges Remain
  - Getting programs properly structured—SEP/TEMP/Risk Management Plan/Exit Criteria/ASR across all programs
  - Refocusing Acquirer and Supplier on technical management of programs

Services and Agencies, along with Industry, must take ownership of the institutionalization of SE

Discussion
Non-Attribution



Are we on the right track?

We want your Feedback!

What are we missing?

Is SE Important?

What do you think?
Are there barriers to SE?
Is this catching on?

Driving Technical Rigor Back Into Programs "Program Support Review Findings"

- Mission Capabilities - Requirements
  - – User requirements not fully defined and/or in flux
  - ☑ Established requirements management plan with all stake holders, including proactive plan for Net-Ready KPP
- Resources - Personnel
  - – Experienced, dedicated PM office staff, but stretched too thin
  - ☑ Expanded, empowered WIPT to bring in technical authority SMEs, users, and DCMA
- Management - Schedule Adequacy
  - – Technical review planning demonstrated schedule was high risk
  - ☑ Lengthen schedule to include full suite of SE technical reviews, supported by adjusted program funding
- Technical Process - Test & Evaluation
  - – Insufficient reliability growth program to meet user requirements by IOT&E
  - ☑ Increased the number of test articles and added sub-system level test events
- Technical Product - Supportability/Maintainability
  - – Logistics demonstration plan just prior to IOT&E
  - ☑ Demonstration re-scheduled prior to MS C

Samples of Program Support Review "Findings" (1 of 2)

- Lack of robust Technology Development (TD) phase activities
  - Necessitates SDD efforts to perform TD activities
  - Begin program initiation with immature technologies
- Reluctance to demonstrate key functionality in SDD phase
  - Integration of Mission Equipment Packages onto platforms; Testing of prototypes
  - Suitability; RAM, including diagnostics and prognostics
  - Avoidance of quantifiable exit criteria for acquisition and test phases
- Test & Evaluation
  - Lack of reliability growth program; Plan to meet ORD threshold by IOC
  - Success oriented T&E schedules
  - Inadequate number of test articles
  - Combined DT/OT is a common goal but is hard to achieve

Samples of Program Support Review "Findings" (2 of 2)

- Lack of overall System of Systems (SoS) integrator with authority and integration resources
  - PMs' hesitant to be dependent on other programs within a SoS
  - Lack of funding commitment for SoS programs
  - Lack of timely Services decisions on major trade studies
    - Decision making not pushed to the lowest level
  - Plan to work issues that cross program and Service lines

- Lack of disciplined SE processes and SE reviews, on all programs
  - Requirements growth leads to SE churn
  - Lack of a robust risk management program
  - Poor communications across IPTs; Lack of empowerment
  - SEPs tend to outline contractor's vice PM's SE execution plan

- Small program offices

- Integration with other management planning
  - Linkage with IMP, IMS, logistics, testing, and risk management
  - Schedule executability: success-oriented vice event-driven
  - Contracting for SE

Driving Technical Rigor Back into Programs "Portfolio Challenge"

- For major acquisition programs (ACAT ID and IAM), Defense Systems was tasked to:
  - Review program's SE Plan (SEP)
  - Review program's T&E Master Plan (TEMP)
  - Conduct Program Support Reviews (PSRs)
- Across these domains:
  - Business Systems
  - Communication Systems
  - C2ISR Systems
  - Fixed Wing Aircraft
  - Unmanned Systems
  - Rotary Wing Aircraft
  - Land Systems
  - Ships
  - Munitions
  - Missiles

Systems Engineering support to over 150 major programs in ten domains

Representative Issues
(1 of 3)

- **Representative Issues for *Schedule***
  - Schedules too aggressive
  - Detailed schedules missing key components
  - Schedule concurrency (e.g. T&E activities)

- **Representative Issues for *Requirements***
  - Requirements don't support planned modifications, increasing capacity
  - Requirements changed without consideration or coordination with PM/PO and dependent programs
  - "Shortsighted" requirements, i.e. safety critical, bandwidth to support future capabilities

- **Representative Issues for *Integration/Interoperability***
  - Integration plans lacking key components
  - Multi-platform, scalable design benefits not realized due to low hw/sw commonality
  - Interoperability with Joint Forces not adequately addressed

Representative Issues
(2 of 3)

- **Representative Issues for *Software***
  - Software processes not institutionalized
  - Software development planning doesn't adequately capture lessons learned to incorporate into successive builds
  - Systems and spiral software requirements undefined
  - Software architecture immature
  - Software reuse strategies are inconsistent across programs
  - Software support plan missing

- **Representative Issues for *Maintainability***
  - Maintainability requirements incomplete or missing
  - Diagnostic effectiveness measures are either too ambiguous or missing
  - Tailoring out of criticality calculations translates to inability to monitor the maintainability status of reliability critical items

Representative Issues
(3 of 3)

- **Representative Issues for *Test and Evaluation***
  - No reliability details (hours, profile, exit criteria, confidence level, OC curve)
  - Lack metrics
  - Basis for some threat-based requirements not fully explained or rationalized

- **Representative Issues for *Systems Engineering***
  - Lack of disciplined SE process, metrics, etc
  - PO not conducting PRR prior to LRIP
  - Missing Joint CONOPs
  - Missing System Functional Review (SFR) and PDR during SDD

Concept Refinement Phase:
Technical Reviews
Alternative System Review (ASR)

- **Purpose**
  - Ensure that resulting requirements agree with customer's needs and expectations and that the system under review can proceed into Technology Development
  - Assesses multiple concepts and assures that the preferred one (s) effectively and efficiently meets the need expressed in the ICD
  - Review of alternative concepts helps ensure that sufficient effort has been given in identifying appropriate solutions
  - One or more concepts can be selected for Technology Development
- **Provided at Completion:**
  - Agreement on the preferred system concept(s) to take into Technology Development phase
  - Hardware and software architectural constraints/drivers to address DII-COE and extensibility
  - Assessment of the full system software concept
  - Comprehensive rationale for the preferred concept
  - Comprehensive assessment of risks relative to COTS and NDI
  - Comprehensive risk assessment for the Technology Development Phase
  - Trade studies/Technical Demonstrations for Concept Risk Reduction
  - Joint requirements for the purposes of compatibility, interoperability, and integration
  - Translation of MOEs into refined thresholds and objectives
  - Completed planning for the TD phase, and initial planning for the SDD phase
  - A draft system requirements document

Technology Development Phase:
Technical Reviews
System Requirements Review (SRR)

- **Purpose and characteristics**
  - **Ascertain *progress* in defining system technical requirements in accordance with program objectives**
  - **Ensure that system requirements are consistent with preferred solution and available technologies**
  - **Understanding of inherent risk in the system specification as well as an acceptable level of risk is critical to a successful review**
  - **May also be repeated at the start of the SD&D Phase**
- **Provided at completion**
  - **An approved preliminary system performance specification;**
  - **A preliminary allocation of system requirements to hardware, human, and software subsystems;**
  - **Identification of all software components (tactical, support, deliverable, non-deliverable, etc.);**
  - **A comprehensive risk assessment for System Development and Demonstration;**
  - **An approved System Development and Demonstration Phase Systems Engineering Plan that addresses cost and critical path drivers; and**
  - **An approved Product Support Plan with updates applicable to this phase.**

Technology Development Phase:
Technical Reviews
System Requirements Review (SRR)

- Typical SRR success criteria include affirmative answers to the following exit questions:
  - **Can the system requirements, as disclosed, satisfy the ICD or draft CDD?**
  - **Are the system requirements sufficiently detailed and understood to enable system functional definition and functional decomposition?**
  - **Is there an approved system performance specification?**
  - **Are adequate processes and metrics in place for the program to succeed?**
  - **Have Human Systems Integration requirements been reviewed and included in the overall system design?**
  - **Are the risks known and manageable for development?**
  - **Is the program schedule executable (technical and/or cost risks)?**
  - **Is the program properly staffed?**
  - **Is the program executable within the existing budget?**
  - **Does the updated cost estimate fit within the existing budget?**
  - **Is the preliminary Cost Analysis Requirements Description consistent with the approved system performance specification?**
  - **Is the software functionality in the system specification consistent with the software sizing estimates and the resource-loaded schedule?**
  - **Did the Technology Development phase sufficiently reduce development risks?**

Preliminary Design Review

- Purpose and characteristics
  - **Ensure that the system can proceed into detailed design**
  - **Assesses the design as captured in the performance specifications for each configuration item**
  - **Ensures that each functional item of the functional baseline has been allocated to one or more configuration items**
- PDR provides
  - **An established system allocated baseline**
  - **An updated risk assessment for System Development and Demonstration**
  - **An updated Cost Analysis Requirements Description (CARD) (or CARD-like document) based on the system allocated baseline**
  - **An updated program schedule including system and software critical path drivers**
  - **An approved Product Support Plan with updates applicable to this phase**

Typical PDR Success Criteria

- Does the status of the technical effort and design indicate operational test success (operationally suitable and effective)?
- Can the preliminary design, as disclosed, satisfy the Capability Development Document?
- Has the system allocated baseline been established and documented to enable detailed design to proceed with proper configuration management?
- Are adequate processes and metrics in place for the program to succeed?
- Have human integration design factors been reviewed and included, where needed, in the overall system design?
- Are the risks known and manageable for development testing and operational testing?
- Is the program schedule executable (technical/cost risks)?
- Is the program properly staffed?
- Is the program executable with the existing budget and with the approved system allocated baseline?
- Does the updated cost estimate fit within the existing budget?
- Is the preliminary design producible within the production budget?
- Is the updated Cost Analysis Requirements Description consistent with the approved allocated baseline?
- Is the software functionality in the approved allocated baseline consistent with the updated software metrics and resource-loaded schedule?

Critical Design Review

- **Purpose and Characteristics**
  - **Ensures that the system under review can proceed into fabrication, test and demonstration**
  - **Asses the final design as captured in the product specifications of each configuration item**
    - **Enables fabrication of hardware and coding of software**
  - **For large systems, CDR may be conducted on subsystem or configuration item level. Together they comprise a complete CDR**
- **CDR provides**
  - **An established system product baseline**
  - **An updated risk assessment for System Development and Demonstration**
  - **An updated Cost Analysis Requirements Description (CARD) (or CARD-like document) based on the system product baseline**
  - **An updated program development schedule including fabrication, test, and software coding critical path drivers**
  - **An approved Product Support Plan with updates applicable to this phase**

Typical CDR Success Criteria

- **Does the status of the technical effort and design indicate operational test success (operationally suitable and effective)?**
- **Does the detailed design, as disclosed, satisfy the CDD or any available draft CPD?**
- **Has the system product baseline been established and documented to enable hardware fabrication and software coding to proceed with proper configuration management?**
- **Has the detailed design satisfied Human Systems Integration (HSI) requirements?**
- **Are adequate processes and metrics in place for the program to succeed?**
- **Are the risks known and manageable for developmental testing and operational testing?**
- **Is the program schedule executable (technical/cost risks)?**
- **Is the program properly staffed?**
- **Is the program executable with the existing budget and the approved product baseline?**

Typical CDR Success Criteria - cont'd

- **Is the detailed design producible within the production budget?**
- **Is the updated CARD consistent with the approved product baseline?**
- **Are Critical Safety Items and Critical Application Items identified?**
- **Does the updated cost estimate fit within the existing budget?**
- **Is the software functionality in the approved product baseline consistent with the updated software metrics and resource-loaded schedule?**
- **Have key product characteristics having the most impact on system performance, assembly, cost, reliability, or safety been identified?**
- **Have the critical manufacturing processes that impact the key characteristics been identified and their capability to meet design tolerances determined?**
- **Have process control plans been developed for critical manufacturing processes?**

Striving for Technical Excellence

- All programs shall develop a SE Plan (SEP)
- Each PEO shall have a lead or chief systems engineer who monitors SE implementation within program portfolio
- Event-driven technical reviews with entry criteria and independent subject matter expert participation
- OSD shall review program's SEP for major acquisition programs (ACAT ID and IAM)

- Technical planning
- Technical leadership
- Technical execution

Technical excellence

Strong technical foundation is the value of SE to the program manager

Driving Technical Rigor Back Into Programs

SEP Focus Areas for Technical Planning in SDD/Production and Deployment

- Program Requirements
  - Capabilities, CONOPS, KPPs
  - Statutory/regulatory
  - Specified/derived performance
  - Certifications
  - Design considerations
- Technical Staffing/Organization
  - Technical authority
  - Lead Systems Engineer
  - IPT coordination
  - IPT organization
  - Organizational depth
- Technical Baseline Management
  - Who is responsible
  - Definition of baselines
  - Requirements traceability
  - Specification tree and WBS link
  - Technical maturity and risk
- Technical Review Planning
  - Event-driven reviews
  - Management of reviews
  - Technical authority chair
  - Key stakeholder participation
  - Peer participation
- Integration with Overall Management of the Program
  - Linkage with other program plans
  - Program manager's role in technical reviews
  - Risk management integration
  - Test and logistics integration
  - Contracting considerations

Driving Technical Rigor Back Into Programs

SEP Focus Areas for Technical Planning in Sustainment

- Program Requirements
  - **Technical surveillance approach**
  - **Tracking of actual vs. planned usage**
  - **Monitoring of system hazards, risks, certifications**
  - **Tracking of usage, corrosion-related maintenance and repair costs, and total ownership costs**
  - **Management of configuration changes and incremental modifications**

- Technical Staffing/Organization
  - Technical authority
  - Lead Systems Engineer
  - **Coordination of sustaining engineering with operational, maintenance, and repair domains**
  - **Sustaining support organization**
  - Organizational depth

- Technical Baseline Management
  - Who is responsible
  - Definition of baseline management
  - **Requirements and certification traceability and verification of changes**
  - Specification tree and WBS link
  - **Tracking of operational hazard risk against baseline**

- Technical Review Planning
  - **In-service reviews**
  - Management of reviews
  - Technical authority chair
  - Key stakeholder participation
  - Peer participation

- Integration with Program Management
  - **Linkage with overall sustainment**
  - **Program manager's role in in-service reviews**
  - Risk management integration
  - Logistics integration
  - Contracting considerations

SE in the System Life Cycle "The Wall Chart"